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Te[illegible] Report S[illegible] on the
B[illegible]osystem-A[illegible]sphere Study (BOREAS)

[illegible]ll and Jaime Nickeson, Editors

[illegible] 44

[illegible]S RSS-2 Extracted Reflectance
[illegible]n ASAS Imagery

[illegible]P. Dabney, W. Kovalick, D. Graham, M. Bur, J. Irons, and M. Tierney

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July [illegible]

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NASA/TM—2000–209891, Vol. 44

Technical Report Series on the Boreal Ecosystem-Atmosphere Study (BOREAS)

Forrest G. Hall and Jaime Nickeson, Editors

Volume 44

BOREAS RSS-2 Extracted Reflectance Factors Derived from ASAS Imagery

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BOREAS RSS-2 Extracted Reflectance Factors Derived from ASAS Imagery

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Summary

The BOREAS RSS-2 team derived atmospherically corrected bidirectional reflectance factor means from multispectral, multiangle ASAS imagery for small homogeneous areas near several BOREAS sites. The ASAS imagery was acquired from the C-130 aircraft platform in 1994 and 1996. The data are stored in tabular ASCII files.

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1. Data Set Overview

1.1 Data Set Identification

BOREAS RSS-02 Extracted Reflectance Factors Derived from ASAS Imagery

1.2 Data Set Introduction

Atmospherically corrected bidirectional reflectance factor means for small homogeneous areas from several BOReal Ecosystem-Atmosphere Study (BOREAS) sites were derived from multispectral, multiangle imagery acquired by the Advanced Solid-state Array Spectroradiometer (ASAS) aboard the C-130 aircraft platform in 1994 and 1996.

At-ground reflectance factors (a mean value for small areas from the ASAS images) have been derived for the Southern Study Area (SSA)-CAL (Airborne Visible InfraRed Imaging Spectrometer (AVIRIS) calibration site), SSA-Old Black Spruce (OBS), SSA-Old Aspen (OA), SSA-Old Jack Pine (OJP), SSA-Young Jack Pine (YJP), and SSA-Fen flux tower sites.

1.3 Objective/Purpose

The purpose was to derive at-surface reflectance factors from airborne multiangle reflected radiance data to study the bidirectional reflectance properties of boreal forest canopies.

1.4 Summary of Parameters

ASAS measures at-sensor radiance of surfaces as a function of spectral wavelength, view geometry (combinations of view zenith angle, view azimuth angle, solar zenith angle, and solar azimuth angle), and altitude. For these data, mean surface reflectance factors have been derived from at-sensor radiances for small areas adjacent to scaffold towers at several flux tower sites and a soil calibration target. Also included are C-130 flight information, date and time of observations, viewing and solar geometry, image subset coordinates, and atmospheric conditions.

1.5 Discussion

The main objectives of BOREAS, conducted in Canada throughout 1994 and 1996, are to improve process models that describe the exchanges of energy, water, carbon, and trace constituents between the boreal forest and the atmosphere, and to develop methods for applying the process models over large spatial scales using remote sensing and other integrative modeling techniques. The Remote Sensing Science (RSS) group, of which ASAS is a part, is responsible for developing linkages between optical and microwave remote sensing and boreal zone biophysical parameters at various scales (leaf, canopy, and regional) using measurements from field, aircraft, and satellite sensors plus a range of radiative transfer models.

Data tables described in this document were derived only from data acquired on 26-May-1994; 21-Jul-1994; and 20-Jul-1996. ASAS at-sensor radiance image data are available for other dates; see the document for ASAS Level 1b image data.

1.6 Related Data Sets

BOREAS RSS-01 PARABOLA Surface Reflectance and Transmittance Data
BOREAS RSS-02 Level-1b ASAS Imagery: At-sensor Radiance in BSQ Format
BOREAS RSS-03 Reflectance Measured from a Helicopter-Mounted Barnes MMR
BOREAS RSS-03 Reflectance Measured from a Helicopter-Mounted SE-590
BOREAS RSS-18 Level-1B AVIRIS Imagery: At-sensor Radiance in BIL Format
BOREAS RSS-19 Background Spectral Reflectance Data

2. Investigator(s)

2.1 Investigator(s) Name and Title

Dr. James R. Irons

2.2 Title of Investigation

Boreal Forest Bidirectional Reflectances Acquired by an Airborne Multispectral, Multiangle Imaging Spectroradiometer

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3. Theory of Measurements

ASAS is an airborne imaging spectroradiometer modified to point off-nadir by the National Aeronautics and Space Administration (NASA) Goddard Space Flight Center (GSFC) for the purpose of remotely observing directional anisotropy of solar radiance reflected from terrestrial surfaces. The instrument is capable of off-nadir pointing from approximately 70 degrees forward to 55 degrees aft along-track (in the direction of flight). As the aircraft approaches and approaches and passes the ground target, digital radiance measurements of the target are recorded for a discrete sequence of fore-to-aft view zenith angles within this range. The terms "tilt," "look," or "view" angles are used interchangeably when referring to the ASAS view zenith angles. For the BOREAS data collection flights, ASAS imaged most study sites at eight different view zenith angles: +70, +60, +45, +26, nadir, -26, -45, and -55 degrees.

Imaging of sites at the 70-degree off-nadir view angle is problematic, and this particular angle may or may not be available in every data set. Data were acquired in 62 spectral bands ranging from 404-1023 nm with a spectral resolution of approximately 10 nm in each band.

See sections below for further details.

4. Equipment

4.1 Sensor/Instrument Description

The ASAS instrument employs a cooled 1024 x 1024 element silicon charged-coupled-device (CCD) detector array to generate multispectral digital image data in a pushbroom mode. The first 324 rows of the CCD are masked. The next 186 rows are exposed to the output from the spectrometer. The final 516 rows are masked and used for readout of the array. Two of the rows under the mask collect smear data which are used to remove smear effects and dark current from the data.

During the BOREAS missions, the operating method of the array was to bin every 3 rows into one spectral band, which resulted in 62 spectral channels. In addition, every 2 detectors within each row were binned, resulting in 512 pixels (per row or line) in the output image data (Level 1b).

In this configuration the spectral band centers, which range from 404 to 1023 nm, are spaced at approximately 10 nm. Each spectral band has a full-width half-maximum (FWHM) of approximately 10 nm.

4.1.1 Collection Environment

The ASAS instrument is mounted on the underside of the platform aircraft fuselage with the sensor optics either slightly protruding into the slipstream or retracted into the fuselage pressure box, depending on the view angle. As the aircraft approaches the target site from a distance, the ASAS instrument is pointed forward-looking. A video camera bore-sighted with the ASAS optical head relays a picture to an onboard monitor screen at the ASAS operator's station. This enables the operator to identify the site and continue tracking it through a sequence of view angles as the aircraft proceeds on a flight line over the site. When the site comes into view on the forward point, the operator begins data acquisition. The sequence is timed such that the view is at nadir when the aircraft is over the site, and aft-looking views are taken after passing the site. Determining which views are forwardscatter or backscatter requires examination of the aircraft heading and the solar azimuth angle.

During 1994 and 1996 BOREAS missions, multiangle data over the flux towers were usually acquired on 3 separate flights in azimuths parallel, perpendicular and oblique to the solar principal plane.

As the platform aircraft flies forward, each row of 512 detector bins is electronically scanned to generate 62 spectral channels of digital image data in a pushbroom mode. The signals generated by the CCD detectors are sampled at a rate of 38 frame lines per second to produce the along-track dimension of the imagery (image lines). The sampled signal from each detector is digitized to 12 bits and the digital data are stored on a high-density S-VHS format tape using a buffered VLDS data recorder.

4.1.2 Source/Platform

NASA Ames Research Center (ARC) C-130 Earth Resources Aircraft (1994) and NASA Wallops Flight Facility (WFF) C-130Q (1996).

4.1.3 Source/Platform Mission Objectives

The mission objectives were to collect multispectral, multiangle bidirectional reflectance data (acquired as at-sensor radiances) over a soil field and flux tower sites for study of boreal forest canopies, and to simulate Multi-Angle Imaging Spectro-Radiometer (MISR) data by obtaining measurements at MISR view angles. At-ground reflectance factors have been derived for some (but not all) data sets.

4.1.4 Key Variables

ASAS measures at-sensor spectral radiance in the visible and near-infrared portion of the spectrum as a function of view geometry. At-ground spectral reflectance for (a) a soil field used as a calibration target and (b) small areas adjacent to the scaffold towers at flux tower sites have been derived using the atmospheric correction algorithm Second Simulation of the Satellite Signal in the Solar Spectrum (6S) (see Section 17.1 for references).

4.1.5 Principles of Operation

The ASAS optical head is mounted in an open port in the underside of the C-130 aircraft. A complex pointing mechanism incorporating a gimbal enables the sensor to view off-nadir, facilitating movement in the horizontal, vertical, rotational fore and aft, and yaw directions.

As the aircraft approaches the target site from a distance, the ASAS instrument is pointed forward-looking. A video camera mounted adjacent to the ASAS optical head relays a picture to an onboard monitor screen at the ASAS operator's station. This enables the operator to identify the site and continue tracking it through a sequence of view angles as the aircraft proceeds on a flight line over the site. When the site comes into view on the first forward angle, the operator initiates data acquisition. The sequence is timed such that the view is at nadir when the aircraft is directly over the site, and aft-looking views are taken after passing the site. Yaw compensation can be performed by the operator (if necessary) to prevent the site from drifting out of the field of view (FOV).

As the platform aircraft flies forward, each row of 1024 x 186 array elements are electronically scanned to generate 62 spectral channels of digital image data in a pushbroom mode. The signals generated by the CCD detectors are sampled at a rate of 38 frame lines per second to produce the along-track dimension of the imagery (image lines). The sampled signal from each detector is digitized

to 12 bits and the digital data are stored on a high-density S-VHS format tape using a buffered VLDS data recorder.

4.1.6 Sensor/Instrument Measurement Geometry

Radiation incident on the ASAS aperture is focused onto an entrance slit by an f/1.4 objective lens with a 57.2 mm focal length. The entrance slit is 50 μm wide across-track, and 23 μm wide along-track. The lens focuses incoming energy through the entrance slit into a 1:1 relay with an effective focal length of 76.3 mm in each half. In each half of the relay, a 90-degree mirror prism folds the optical path to create a compact optical head. A transmission grating ruled at 75 lines per mm and blazed at 530 nm is located between the two prisms to disperse the radiant energy into its wavelength spectrum, which is in turn directed by the second prism onto the 186 rows of the array in the focal plane, where the CCD is mounted.

The instantaneous field of view (IFOV) of an ASAS pixel is a function of optics, detector dimensions, tilt angle (view angle), and aircraft altitude and attitude (pitch and roll). The optical system includes an f/1.4 objective lens with a 57.2 mm focal length, providing a 0.33 rad (19.3 degree) total angular across-track FOV. The individual angular resolution of the center detectors is 0.66 mrad across-track. The along-track FOV is 0.44 mrad.

Each detector has dimensions of 19.0 micrometers spatially (across-track) and 19.0 micrometers spectrally, however with a binning factor of 2 in the spatial dimension and 3 in the spectral dimension, the resulting array pixel size is 38.0 micrometers in the spatial dimension and 57 micrometers in the spectral dimension.

4.1.7 Manufacturer of Sensor/Instrument

The ASAS instrument evolved over a number of years. The original optics, built by TRW, were part of the Scanning Imaging Spectroradiometer (SIS) constructed in the early 1970s for NASA's Johnson Space Center (JSC). ASAS was created in 1981 when a charge-injection device (CID) silicon detector array, made by GE, was incorporated with the optical system for a joint program involving NASA JSC and the Naval Ocean Systems Center. In 1984, the sensor was transferred to NASA GSFC, where the aircraft mounting bracket was modified for off-nadir pointing.

In late 1991, the pointing mechanism was upgraded by NASA GSFC to allow view angles of 70 degrees forward to 55 degrees aft, and to enable operator-controlled aircraft yaw compensation. In 1992, the CID was replaced with a Thomson CSF Model TH7896A (high speed version) CCD silicon detector array. BOREAS data were acquired with this CCD array.

4.2 Calibration

Radiometric Calibration

Radiometric calibration data for the BOREAS experiment were acquired from two primary calibration sources: 1) a 1.2 m diameter integrating hemisphere in the NASA GSFC calibration laboratory, and 2) a 30 inch (0.76 m) diameter portable hemisphere that is owned and operated by GSFC. The latter source was used for in situ calibration data acquisition since it could be positioned directly under the aircraft-mounted instrument. The integrating hemisphere is operated and maintained by the Sensor Development and Characterization Branch at NASA GSFC. Up to 12 levels of radiance can be provided for calibration by turning the internal tungsten filament lamps on or off. The hemisphere is calibrated on an absolute scale by comparison to the output from a National Institute of Standards and Technology (NIST) traceable calibration lamp using a laboratory-based transfer spectroradiometer. In a calibration run, ASAS is exposed to a 12-level sequence of spectral radiance levels from the hemisphere. Dark current (the response of the instrument under conditions of no incident radiation) is also acquired.

More detailed information about ASAS radiometric calibration can be found in the document for ASAS Level 1b images. See Section 1.6.

Spectral Calibration

A McPherson Model 285 0.5 m double monochromator serves as the spectral reference source for ASAS. Light from the monochromator is collimated by a paraboloid mirror and directed to the ASAS optics. Instrument output is sampled every 0.5 nm. The band centers have been computed by determining the centroid of the area under the response curve for each band. FWHM was measured directly from the response curves.

4.2.1 Specifications

ASAS spectral band centers and FWHM applicable to 1994 and 1996 BOREAS data sets are as follows:

Band	Center (nm)	FWHM (nm)	Band	Center (nm)	FWHM (nm)
1	404.3	9.5	32	711.9	11.0
2	413.7	9.5	33	722.1	11.0
3	423.2	9.5	34	732.3	11.0
4	432.4	10.0	35	742.6	11.0
5	441.7	10.0	36	752.9	11.0
6	451.4	10.0	37	763.2	11.0
7	460.9	10.0	38	773.5	11.0
8	470.5	10.0	39	783.8	11.5
9	480.3	10.5	40	794.1	11.0
10	490.2	10.5	41	804.5	11.0
11	500.0	10.0	42	814.9	11.0
12	509.7	10.5	43	825.3	11.5
13	519.6	10.0	44	835.7	11.0
14	529.7	10.5	45	846.0	11.0
15	539.9	10.5	46	856.4	11.0
16	549.8	10.5	47	866.8	11.0
17	559.6	10.0	48	877.2	11.5
18	569.4	10.5	49	887.6	11.5
19	579.4	10.5	50	897.9	11.0
20	589.7	11.0	51	908.3	11.0
21	600.0	10.5	52	918.7	11.0
22	610.2	11.0	53	929.0	11.0
23	620.3	10.5	54	939.5	10.5
24	630.4	10.5	55	949.9	11.0
25	640.7	11.0	56	960.3	11.0
26	650.9	10.5	57	970.7	11.0
27	661.1	11.0	58	981.1	11.0
28	671.4	10.5	59	991.5	10.5
29	681.5	11.0	60	1001.9	10.5
30	691.6	11.0	61	1012.2	10.5
31	701.7	11.0	62	1022.7	10.5

4.2.1.1 Tolerance

Information on spectral radiometric resolution factors and periodic horizontal striping (relevant to ASAS Level 1b images) is presented in this section in the document on ASAS Level 1b images. See Section 1.6.

4.2.2 Frequency of Calibration

In general, ASAS acquires radiometric calibration data at least twice for each mission, with one calibration set acquired prior to the mission, followed by a postmission calibration after the instrument arrives back at GSFC. Radiometric calibration data were also acquired during each BOREAS field campaign using the portable integrating hemisphere described elsewhere in this document. For dates of calibration data used to calibrate BOREAS field data, see this section in the document for ASAS Level 1b images.

Laboratory spectral calibrations of ASAS were performed both before and after the 1994 BOREAS field season. The spectral stability was also checked once in the middle of the field season using a portable helium neon laser. It has been determined that the spectral calibration results from 13-Oct-1994 are most appropriate for all 1994 and 1996 BOREAS data sets.

4.2.3 Other Calibration Information

None.

5. Data Acquisition Methods

The ASAS instrument is mounted on the underside of the platform aircraft fuselage with the sensor optics either slightly protruding into the slipstream or retracted into the fuselage pressure box, depending on the view angle. As the aircraft approaches the target site from a distance, the ASAS instrument is pointed forward-looking. A video camera bore-sighted with the ASAS optical head relays a picture to an onboard monitor screen at the ASAS operator's station. The operator identifies the site and tracks it through a sequence of view angles as the aircraft proceeds on a flight line over the site. When the site comes into view on the forward point, the operator begins data acquisition. The sequence is timed such that the view is at nadir when the aircraft is directly over the site, and aft-looking views are taken after passing the site. Determining which views are forwardscatter and backscatter requires examination of the aircraft heading and the solar azimuth angle, given in the ASAS American Standard Code for Information Interchange (ASCII) header.

During 1994 and 1996 BOREAS missions, data were acquired as follows: flux towers at multiple view zenith angles on view azimuths parallel, perpendicular, and oblique to the solar principal plane.

As the platform aircraft flies forward, each row of 512 detector bins is electronically scanned to generate 62 spectral channels of digital image data in a pushbroom mode. Signals generated by the CCD detectors are sampled at a rate of 38 frame lines per second to produce the along-track dimension of the imagery (image lines). The sampled signal from each detector is digitized to 12 bits and the digital data are stored on a high-density S-VHS format tape using a buffered VLDS data recorder.

6. Observations

6.1 Data Notes

None.

6.2 Field Notes

ASAS operators do not make extensive notes about field conditions during missions. ASAS usually is not flown if atmospheric conditions are not sufficiently clear. Any observations noted by ASAS operators are made at altitude, and if considered pertinent to the data, are included in the ASAS header (of Level 1b images) COMMENTS field.

7. Data Description

7.1 Spatial Characteristics

7.1.1 Spatial Coverage

At-ground reflectance factors (a mean value for small areas from the ASAS images) have been derived for the SSA-CAL (AVIRIS calibration site), SSA-OBS, SSA-OA, SSA-OJP, SSA-YJP, and SSA-Fen flux tower sites. At-sensor radiance images (ASAS Level 1b) are available for more sites in the SSA and for sites in the NSA. See the document on ASAS Level 1b images. The North American Datum of 1983 (NAD83) coordinates for the sites are:

Site	Latitude	Longitude
SSA_FEN	53.801° N	104.619° W
SSA_OA	53.629° N	106.198° W
SSA_OBS	53.988° N	105.119° W
SSA_OJP	53.916° N	104.690° W
SSA_YJP	53.876° N	104.647° W
SSA_AVIRIS_CAL	53.24° N	105.69° W

7.1.2 Spatial Coverage Map

Not available.

7.1.3 Spatial Resolution

Across-track direction (x):

ASAS spatial resolution in the x-direction is a function of the across-track FOV, view angle, and the altitude of the platform aircraft. Across-track pixels do not overlap. The across-track pixel size (in meters) is given in the header of each ASAS Level 1b image, however this information is not retained in the at-ground reflectance factor tables.

Approximate ASAS pixel sizes are given below (the platform aircraft flew at slightly different altitudes in the two different years):

Tilt angle (degrees)	1994 x pixel size (meters)	1996 x pixel size (meters)
+70	10.7	9.0
+60	7.3	6.2
+45	5.2	4.4
+26	4.1	3.4
00	3.6	3.1
-26	4.1	3.4
-45	5.2	4.4
-55	6.4	5.4

Along-track direction (y):

The along-track spatial resolution of an ASAS image pixel is more complicated. For a detailed explanation, see the document for ASAS Level 1b images.

All ASAS data sets are oversampled in the along-track direction. This means that each image line somewhat overlaps the previous line, making the images appear more elongated than in reality. This frame or line overlap is not corrected for during operational processing. Essentially, the along-track pixel size is determined by the aircraft ground speed divided by the data frame rate, and this represents the smear distance portion of each pixel in the y-direction. For both 1994 and 1996 ASAS BOREAS data, this along-track (y) pixel size was approximately 3 m in all tilt angles.

The ASAS multiangle images have not been georegistered, and though the sampled areas are selected carefully, they are not guaranteed to represent the exact same area in each image.

7.1.4 Projection
Not applicable.

7.1.5 Grid Description
Not applicable.

7.2 Temporal Characteristics

7.2.1 Temporal Coverage
The data cover various dates over the period of 26-MAY-94 to 20-JUL-96.

7.2.2 Temporal Coverage Map
Current coverage for at-ground reflectance factor tables:

DATE	SITE	FLIGHT LINES
26-May-1994	SSA_CAL	1
21-Jul-1994	SSA_OBS	3
	SSA_OA	3
	SSA_OJP	3
	SSA_YJP	1
	SSA_FEN	1
20-Jul-1996	SSA_FEN	1

7.2.3 Temporal Resolution
ASAS site passes may vary slightly in time duration, depending on the length of the flight line and the aircraft speed. Typically one multiangle pass over a site has a time duration of about 5 minutes.

At-ground reflectance factor tables have been generated for three dates only at this time: 26-May-1994; 21-Jul-1994; and 20-Jul-1996.

7.3 Data Characteristics

7.3.1 Parameter/Variable
The parameters contained in the data files on the CD-ROM are:

Reference File

Column Name
SITE_NAME
SUB_SITE
DATE_OBS
TIME
C130_LINE_NUM
C130_RUN_NUM
PLATFORM_ALTITUDE
C130_TRUE_HEADING
RELATIVE_SOLAR_POSITION
SOLAR_ZEN_ANG
SOLAR_AZ_ANG
CENTER_VIEW_ZEN_ANG
CENTER_VIEW_AZ_ANG

```
RELATIVE_VIEW_AZ_ANG
ASAS_EXTRACTION_START_LINE
ASAS_EXTRACTION_START_SAMPLE
ASAS_EXTRACTION_END_LINE
ASAS_EXTRACTION_END_SAMPLE
COLUMN_WATER_VAPOR_6S
OZONE_CONTENT_6S
INTERP_AEROSOL_OPT_THICK_550
EST_BELOW_PLATFORM_WATER_VAPOR
EST_BELOW_PLATFORM_OZONE
EST_BELOW_PLATFORM_AOT_550
CRTFCN_CODE
REVISION_DATE
```

Data File

```
         Column Name
------------------------------
SITE_NAME
SUB_SITE
DATE_OBS
TIME
WAVELENGTH
ASAS_CHANNEL_NUM
CENTER_VIEW_ZEN_ANG
MEAN_RADIANCE
SDEV_RADIANCE
MEAN_SURF_RAD
SDEV_SURF_RAD
MEAN_SURF_REFL
SDEV_SURF_REFL
DIRECT_DOWN_SOLAR_IRRAD
DIFFUSE_DOWN_SOLAR_IRRAD
ENV_DOWN_SOLAR_IRRAD
CRTFCN_CODE
REVISION_DATE
```

7.3.2 Variable Description/Definition

The descriptions of the parameters contained in the data files on the CD-ROM are:

Reference File

Column Name	Description
SITE_NAME	The identifier assigned to the site by BOREAS, in the format SSS-TTT-CCCCC, where SSS identifies the portion of the study area: NSA, SSA, REG, TRN, and TTT identifies the cover type for the site, 999 if unknown, and CCCCC is the identifier for site, exactly what it means will vary with site type.
SUB_SITE	The identifier assigned to the sub-site by BOREAS, in the format GGGGG-IIIII, where GGGGG is the group associated with the sub-site instrument e.g. HYD06 or STAFF, and IIIII is the identifier for sub-site, often this will refer to

	an instrument.
DATE_OBS	The date on which the data were collected.
TIME	The Greenwich Mean Time (GMT) when the data were collected.
C130_LINE_NUM	The number of the C130 line in its flights over the BOREAS area as given in the flight logs. Zero values are given for non-"official" C130 missions and for data between C130 sites or lines.
C130_RUN_NUM	The number of the C130 run in its flights over the BOREAS area as given in the flight logs. Zero value is given for non-"official" C130 missions and data between C130 sites, lines or runs.
PLATFORM_ALTITUDE	The nominal altitude of the data collection platform above the target.
C130_TRUE_HEADING	The nominal azimuthal direction, measured clockwise from North, along which the center line of the C-130 aircraft was aligned during the flight.
RELATIVE_SOLAR_POSITION	The relative position of the aircraft flight line to the solar position, the values being either parallel, perpendicular, or oblique.
SOLAR_ZEN_ANG	The angle from the surface normal (straight up) to the sun during the data collection.
SOLAR_AZ_ANG	The azimuthal direction of the sun during data collection expressed in clockwise increments from North.
CENTER_VIEW_ZEN_ANG	At the center of the scene, the angle from the surface normal (straight up) to the observing instrument.
CENTER_VIEW_AZ_ANG	The azimuthal direction in which the radiant energy was traveling when collected by the instrument and expressed in clockwise increments from North.
RELATIVE_VIEW_AZ_ANG	The azimuthal angle at which the radiant energy was traveling when measured by the sensor, relative to the solar azimuth. The relative view azimuth angle increases in a clockwise direction from the solar position.
ASAS_EXTRACTION_START_LINE	The starting line in the ASAS image from which values were extracted to derive BRDF estimations.
ASAS_EXTRACTION_START_SAMPLE	The starting sample in the ASAS image from which values were extracted to derive BRDF estimations.
ASAS_EXTRACTION_END_LINE	The ending line in the ASAS image from which values were extracted to derive BRDF estimations.
ASAS_EXTRACTION_END_SAMPLE	The ending sample in the ASAS image from which values were extracted to derive BRDF estimations.
COLUMN_WATER_VAPOR_6S	The modeled amount of precipitable water in the total vertical column of air with a cross-section of 1 centimeter squared output from the 6S atmospheric model.
OZONE_CONTENT_6S	The modeled total column abundance of ozone, output from the 6S atmospheric model.

INTERP_AEROSOL_OPT_THICK_550	The aerosol optical depth interpolated to 550 nanometers, used in the atmospheric correction.
EST_BELOW_PLATFORM_WATER_VAPOR	The estimated amount of precipitable water within a vertical column of air between the ground and the aircraft, with a cross-section of 1 centimeter squared (modeled).
EST_BELOW_PLATFORM_OZONE	The estimated column abundance of ozone below the aircraft (modeled).
EST_BELOW_PLATFORM_AOT_550	The estimated aerosol optical depth for the air column below the aircraft (modeled).
CRTFCN_CODE	The BOREAS certification level of the data. Examples are CPI (Checked by PI), CGR (Certified by Group), PRE (Preliminary), and CPI-??? (CPI but questionable).
REVISION_DATE	The most recent date when the information in the referenced data base table record was revised.

Data File

Column Name	Description
SITE_NAME	The identifier assigned to the site by BOREAS, in the format SSS-TTT-CCCCC, where SSS identifies the portion of the study area: NSA, SSA, REG, TRN, and TTT identifies the cover type for the site, 999 if unknown, and CCCCC is the identifier for site, exactly what it means will vary with site type.
SUB_SITE	The identifier assigned to the sub-site by BOREAS, in the format GGGGG-IIIII, where GGGGG is the group associated with the sub-site instrument e.g. HYD06 or STAFF, and IIIII is the identifier for sub-site, often this will refer to an instrument.
DATE_OBS	The date on which the data were collected.
TIME	The Greenwich Mean Time (GMT) when the data were collected.
WAVELENGTH	Spectral wavelength at which measurement was acquired.
ASAS_CHANNEL_NUM	The ASAS designation for channel number, sequential from 1 to 62.
CENTER_VIEW_ZEN_ANG	At the center of the scene, the angle from the surface normal (straight up) to the observing instrument.
MEAN_RADIANCE	The mean at-sensor radiance.
SDEV_RADIANCE	The standard deviation of at-sensor radiance.
MEAN_SURF_RAD	The mean atmospherically corrected surface radiance
SDEV_SURF_RAD	The standard deviation of atmospherically corrected surface radiance
MEAN_SURF_REFL	The mean surface reflectance factor (atmospherically corrected).
SDEV_SURF_REFL	The standard deviation of atmospherically corrected surface reflectance factor
DIRECT_DOWN_SOLAR_IRRAD	Downwelling solar spectral irradiance from 6S

	model; direct component reaches surface on first sun-surface path without scattering.
DIFFUSE_DOWN_SOLAR_IRRAD	Downwelling solar spectral irradiance from 6S model; diffuse component is the scattered flux on the first sun-surface path, independent of surface properties.
ENV_DOWN_SOLAR_IRRAD	Downwelling solar spectral irradiance from 6S model; environmental component has been scattered between the surface and atmosphere and thus is dependent on surface albedo.
CRTFCN_CODE	The BOREAS certification level of the data. Examples are CPI (Checked by PI), CGR (Certified by Group), PRE (Preliminary), and CPI-??? (CPI but questionable).
REVISION_DATE	The most recent date when the information in the referenced data base table record was revised.

7.3.3 Unit of Measurement

The measurement units for the parameters contained in the data files onthe CD-ROM are:

Reference File

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
TIME	[HHMMSS GMT]
C130_LINE_NUM	[none]
C130_RUN_NUM	[none]
PLATFORM_ALTITUDE	[meters]
C130_TRUE_HEADING	[degrees]
RELATIVE_SOLAR_POSITION	[none]
SOLAR_ZEN_ANG	[degrees]
SOLAR_AZ_ANG	[degrees]
CENTER_VIEW_ZEN_ANG	[degrees]
CENTER_VIEW_AZ_ANG	[degrees]
RELATIVE_VIEW_AZ_ANG	[degrees]
ASAS_EXTRACTION_START_LINE	[none]
ASAS_EXTRACTION_START_SAMPLE	[none]
ASAS_EXTRACTION_END_LINE	[none]
ASAS_EXTRACTION_END_SAMPLE	[none]
COLUMN_WATER_VAPOR_6S	[millimeters]
OZONE_CONTENT_6S	[Dobson units]
INTERP_AEROSOL_OPT_THICK_550	[unitless]
EST_BELOW_PLATFORM_WATER_VAPOR	[millimeters]
EST_BELOW_PLATFORM_OZONE	[Dobson units]
EST_BELOW_PLATFORM_AOT_550	[unitless]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

Data File

Column Name	Units
SITE_NAME	[none]
SUB_SITE	[none]
DATE_OBS	[DD-MON-YY]
TIME	[HHMMSS GMT]
WAVELENGTH	[micrometers]
ASAS_CHANNEL_NUM	[none]
CENTER_VIEW_ZEN_ANG	[degrees]
MEAN_RADIANCE	[Watts][meter^-2][steradian^-1][micrometer^-1]
SDEV_RADIANCE	[Watts][meter^-2][steradian^-1][micrometer^-1]
MEAN_SURF_RAD	[Watts][meter^-2][steradian^-1][micrometer^-1]
SDEV_SURF_RAD	[Watts][meter^-2][steradian^-1][micrometer^-1]
MEAN_SURF_REFL	[percent]
SDEV_SURF_REFL	[percent]
DIRECT_DOWN_SOLAR_IRRAD	[Watts][meter^-2][micrometer^-1]
DIFFUSE_DOWN_SOLAR_IRRAD	[Watts][meter^-2][micrometer^-1]
ENV_DOWN_SOLAR_IRRAD	[Watts][meter^-2][micrometer^-1]
CRTFCN_CODE	[none]
REVISION_DATE	[DD-MON-YY]

7.3.4 Data Source

The sources of the parameter values contained in the data files on the CD-ROM are:

Reference File

Column Name	Data Source
SITE_NAME	[Assigned by BORIS Staff]
SUB_SITE	[Assigned by BORIS Staff]
DATE_OBS	[ASAS data system (recorded with data)]
TIME	[ASAS data system (recorded with data)]
C130_LINE_NUM	[ASAS flight logs]
C130_RUN_NUM	[ASAS flight logs]
PLATFORM_ALTITUDE	[C130 navigation information]
C130_TRUE_HEADING	[C130 navigation information]
RELATIVE_SOLAR_POSITION	[ASAS data system (recorded with data)]
SOLAR_ZEN_ANG	[Calculated by ASAS software]
SOLAR_AZ_ANG	[Calculated by ASAS software]
CENTER_VIEW_ZEN_ANG	[ASAS data system (recorded with data)]
CENTER_VIEW_AZ_ANG	[Calculated by ASAS data system software]
RELATIVE_VIEW_AZ_ANG	[Calculated by ASAS data system software]
ASAS_EXTRACTION_START_LINE	[Obtained in image analysis software]
ASAS_EXTRACTION_START_SAMPLE	[Obtained in image analysis software]
ASAS_EXTRACTION_END_LINE	[Obtained in image analysis software]
ASAS_EXTRACTION_END_SAMPLE	[Obtained in image analysis software]
COLUMN_WATER_VAPOR_6S	[Modeled and output by 6S]
OZONE_CONTENT_6S	[Modeled and output by 6S]
INTERP_AEROSOL_OPT_THICK_550	[Interpolated from BORIS RSS11 and RSS12 data sets, then input to 6S]
EST_BELOW_PLATFORM_WATER_VAPOR	[Modeled and output by 6S]
EST_BELOW_PLATFORM_OZONE	[Modeled and output by 6S]
EST_BELOW_PLATFORM_AOT_550	[Modeled and output by 6S]
CRTFCN_CODE	[Assigned by BORIS Staff]
REVISION_DATE	[Assigned by BORIS Staff]

Data File

Column Name	Data Source
SITE_NAME	[Assigned by BORIS Staff]
SUB_SITE	[Assigned by BORIS Staff]
DATE_OBS	[ASAS data system (recorded with data)]
TIME	[ASAS data system (recorded with data)]
WAVELENGTH	[ASAS spectral response files]
ASAS_CHANNEL_NUM	[ASAS software]
CENTER_VIEW_ZEN_ANG	[Calculated by ASAS data system software]
MEAN_RADIANCE	[Calculated by image analysis software]
SDEV_RADIANCE	[Calculated by image analysis software]
MEAN_SURF_RAD	[6S output]
SDEV_SURF_RAD	[ASAS software that runs 6S]
MEAN_SURF_REFL	[6S output]
SDEV_SURF_REFL	[ASAS software that runs 6S]
DIRECT_DOWN_SOLAR_IRRAD	[6S output]
DIFFUSE_DOWN_SOLAR_IRRAD	[6S output]
ENV_DOWN_SOLAR_IRRAD	[6S output]
CRTFCN_CODE	[Assigned by BORIS Staff]
REVISION_DATE	[Assigned by BORIS Staff]

7.3.5 Data Range

The following table gives information about the parameter values found in the data files on the CD-ROM.

Reference File

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	NSA-FEN-FLXTR	SSA-YJP-FLXTR	None	None	None	None
SUB_SITE	RSS02-BRF01	RSS02-BRF01	None	None	None	None
DATE_OBS	26-MAY-94	20-JUL-96	None	None	None	None
TIME	153838	211436	None	None	None	None
C130_LINE_NUM	101	703	None	None	None	None
C130_RUN_NUM	1	2	None	None	None	None
PLATFORM_ALTITUDE	5130	6177	None	None	None	None
C130_TRUE_HEADING	19	340	None	None	None	None
RELATIVE_SOLAR_POSITION	oblique	perpendicular	None	None	None	None
SOLAR_ZEN_ANG	33.5	46	None	None	None	None
SOLAR_AZ_ANG	117.9	229.4	None	None	None	None
CENTER_VIEW_ZEN_ANG	.3	70	None	None	None	None
CENTER_VIEW_AZ_ANG	18.2	351.2	None	None	None	None
RELATIVE_VIEW_AZ_ANG	.244	359.925	None	None	None	None
ASAS_EXTRACTION_START_LINE	22	1809	None	None	None	None
ASAS_EXTRACTION_START_SAMPLE	22	489	None	None	None	None
ASAS_EXTRACTION_END_LINE	36	1823	None	None	None	None
ASAS_EXTRACTION_END_SAMPLE	38	504	None	None	None	None

COLUMN_WATER_VAPOR_6S	14.2	14.2	None	None	None	None
OZONE_CONTENT_6S	340	340	None	None	None	None
INTERP_AEROSOL_OPT_THICK_550	.054	.09	None	None	None	None
EST_BELOW_PLATFORM_WATER_VAPOR	10.45	12.16	None	None	None	None
EST_BELOW_PLATFORM_OZONE	10	10	None	None	None	None
EST_BELOW_PLATFORM_AOT_550	.05	.086	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	19-JAN-99	19-JAN-99	None	None	None	None

Data File

Column Name	Minimum Data Value	Maximum Data Value	Missng Data Value	Unrel Data Value	Below Detect Limit	Data Not Cllctd
SITE_NAME	NSA-FEN-FLXTR	SSA-YJP-FLXTR	None	None	None	None
SUB_SITE	RSS02-BRF01	RSS02-BRF01	None	None	None	None
DATE_OBS	26-MAY-94	20-JUL-96	None	None	None	None
TIME	153838	211436	None	None	None	None
WAVELENGTH	.4043	1.0227	None	None	None	None
ASAS_CHANNEL_NUM	1	62	None	None	None	None
CENTER_VIEW_ZEN_ANG	.3	70	None	None	None	None
MEAN_RADIANCE	1.806	128.437	None	None	None	None
SDEV_RADIANCE	.19	40.753	None	None	None	None
MEAN_SURF_RAD	0	130.893	None	None	None	None
SDEV_SURF_RAD	0	41.955	None	None	None	None
MEAN_SURF_REFL	0	67.9	None	None	None	None
SDEV_SURF_REFL	0	25.1	None	None	None	None
DIRECT_DOWN_SOLAR_IRRAD	214.688	1212.9	None	None	None	None
DIFFUSE_DOWN_SOLAR_IRRAD	7.84	293.149	None	None	None	None
ENV_DOWN_SOLAR_IRRAD	0	20.063	None	None	None	None
CRTFCN_CODE	CPI	CPI	None	None	None	None
REVISION_DATE	15-JAN-99	15-JAN-99	None	None	None	None

Minimum Data Value -- The minimum value found in the column.

Maximum Data Value -- The maximum value found in the column.

Missng Data Value -- The value that indicates missing data. This is used to indicate that an attempt was made to determine the parameter value, but the attempt was unsuccessful.

Unrel Data Value -- The value that indicates unreliable data. This is used to indicate an attempt was made to determine the parameter value, but the value was deemed to be unreliable by the analysis personnel.

Below Detect Limit -- The value that indicates parameter values below the instruments detection limits. This is used to indicate that an attempt was made to determine the parameter value, but the analysis personnel determined

```
                          that the parameter value was below the detection
                          limit of the instrumentation.
Data Not Cllctd     -- This value indicates that no attempt was made to
                          determine the parameter value.  This usually
                          indicates that BORIS combined several similar but
                          not identical data sets into the same data base table
                          but this particular science team did not
                          measure that parameter.
Blank -- Indicates that blank spaces are used to denote that type of value.
N/A   -- Indicates that the value is not applicable to the respective column.
None  -- Indicates that no values of that sort were found in the column.
-------------------------------------------------------------------------------
```

7.4 Sample Data Record

The following are wrapped versions of data record from a sample data file on the CD-ROM.

Reference File

```
SITE_NAME,SUB_SITE,DATE_OBS,TIME,C130_LINE_NUM,C130_RUN_NUM,PLATFORM_ALTITUDE,
C130_TRUE_HEADING,RELATIVE_SOLAR_POSITION,SOLAR_ZEN_ANG,SOLAR_AZ_ANG,
CENTER_VIEW_ZEN_ANG,CENTER_VIEW_AZ_ANG,RELATIVE_VIEW_AZ_ANG,
ASAS_EXTRACTION_START_LINE,ASAS_EXTRACTION_START_SAMPLE,ASAS_EXTRACTION_END_LINE,
ASAS_EXTRACTION_END_SAMPLE,COLUMN_WATER_VAPOR_6S,OZONE_CONTENT_6S,
INTERP_AEROSOL_OPT_THICK_550,EST_BELOW_PLATFORM_WATER_VAPOR,
EST_BELOW_PLATFORM_OZONE,EST_BELOW_PLATFORM_AOT_550,CRTFCN_CODE,REVISION_DATE
'SSA-999-CALIB','RSS02-BRF01',26-MAY-94,172628,601,2,6038.0,322.0,'parallel',
36.7,142.0,45.0,143.3,181.27,199,210,294,255,14.2,340.0,.085,11.29,10.0,.081,
'CPI',19-JAN-99
'SSA-999-CALIB','RSS02-BRF01',26-MAY-94,172655,601,2,6038.0,322.0,'parallel',
36.7,142.1,26.0,143.9,181.806,191,204,292,266,14.2,340.0,.085,11.29,10.0,.081,
'CPI',19-JAN-99
'SSA-999-CALIB','RSS02-BRF01',26-MAY-94,172717,601,2,6038.0,322.0,'parallel',
36.7,142.3,.9,223.2,260.884,197,198,292,267,14.2,340.0,.085,11.29,10.0,.081,
'CPI',19-JAN-99
```

Data File

```
SITE_NAME,SUB_SITE,DATE_OBS,TIME,WAVELENGTH,ASAS_CHANNEL_NUM,CENTER_VIEW_ZEN_ANG,
MEAN_RADIANCE,SDEV_RADIANCE,MEAN_SURF_RAD,SDEV_SURF_RAD,MEAN_SURF_REFL,
SDEV_SURF_REFL,DIRECT_DOWN_SOLAR_IRRAD,DIFFUSE_DOWN_SOLAR_IRRAD,
ENV_DOWN_SOLAR_IRRAD,CRTFCN_CODE,REVISION_DATE
'SSA-FEN-FLXTR','RSS02-BRF01',21-JUL-94,203607,.4043,1,70.0,4.195,2.127,0.0,0.0,
0.0,0.0,717.179,280.863,0.0,'CPI',15-JAN-99
'SSA-FEN-FLXTR','RSS02-BRF01',21-JUL-94,203607,.4137,2,70.0,8.755,1.224,0.0,0.0,
0.0,0.0,805.467,279.034,0.0,'CPI',15-JAN-99
'SSA-FEN-FLXTR','RSS02-BRF01',21-JUL-94,203607,.4232,3,70.0,15.941,1.345,0.0,0.0,
0.0,0.0,806.568,259.515,0.0,'CPI',15-JAN-99
'SSA-FEN-FLXTR','RSS02-BRF01',21-JUL-94,203607,.4324,4,70.0,22.857,1.212,0.0,0.0,
0.0,0.0,815.609,237.903,0.0,'CPI',15-JAN-99
```

8. Data Organization

8.1 Data Granularity

The smallest unit of data tracked by the BOREAS Information System (BORIS) was the data collected at a given site on a given date.

8.2 Data Format(s)

The Compact Disk-Read-Only Memory (CD-ROM) files contain ASCII numerical and character fields of varying length separated by commas. The character fields are enclosed with single apostrophe marks. There are no spaces between the fields.

Each data file on the CD-ROM has four header lines of Hyper-Text Markup Language (HTML) code at the top. When viewed with a Web browser, this code displays header information (data set title, location, date, acknowledgments, etc.) and a series of HTML links to associated data files and related data sets. Line 5 of each data file is a list of the column names, and line 6 and following lines contain the actual data.

9. Data Manipulations

9.1 Formulae

Not applicable.

9.1.1 Derivation Techniques and Algorithms

See references for 6S (Section 17.1).

9.2 Data Processing Sequence

9.2.1 Processing Steps

The processing of raw ASAS data to at-sensor radiances is explained in detail in the document for ASAS Level 1b images. Processing beyond the at-sensor radiances to produce the at-ground reflectance tables was as follows:

- ASAS multiangle images were displayed using Interactive Data Language (IDL) software.
- From each tilt angle image, roughly the same small image area was delineatedusing IDL software.
- View angle information and radiance statistics were extracted for the sampled polygon in each tilt angle image.
- 6S corrected the mean at-sensor spectral radiances for atmospheric effects and directly output table parameters.

9.2.2 Processing Changes

Not applicable.

9.3 Calculations

See 6S references (Section 17.1).

9.3.1 Special Corrections/Adjustments

See 6S references (Section 17.1).

9.3.2 Calculated Variables

Calculated (derived) variables: at-ground radiance, at-ground reflectance factor.

9.4 Graphs and Plots

Not applicable.

10. Errors

10.1 Sources of Error

Potential sources of uncertainty associated with ASAS spectral radiance and at-ground reflectance factors include the following: spectral radiance from the integrating hemisphere, spectral radiance from the portable hemisphere, transfer of spectral radiance to ASAS detector elements, spectral calibration of ASAS detector elements, and the atmospheric correction algorithm. Other factors such as polarization sensitivity, signal cross-talk between detectors, and stray light may contribute to the uncertainty, but these factors have not been evaluated.

10.2 Quality Assessment

10.2.1 Data Validation by Source

ASAS Level 1b Image Data: During processing, frequency histograms of selected channels for each view angle are plotted and examined manually for anomalies. Images are also displayed and visually analyzed for target coverage, data dropouts, saturation, and other potential problems.

Derived Reflectance Factors: ASAS atmospherically corrected reflectance factors are compared to reflectances acquired on the ground at the same sites when available; in most cases, ASAS reflectance factors have compared well to ground observations especially for the spectral range from 490 to 860 nm.

10.2.2 Confidence Level/Accuracy Judgment

The uncertainty associated with ASAS spectral radiance values is approximately 6%. This number is the root-sum-square of the uncertainties contributed by the following factors: spectral radiance from the integrating hemisphere (5% uncertainty); transfer of spectral radiance to ASAS detector elements (2% uncertainty); and spectral calibration of the ASAS detector elements (1% uncertainty). The uncertainty associated with the radiance of the portable hemisphere has not been determined; however, it is probably similar to that of the integrating hemisphere. Other factors such as polarization sensitivity, signal cross-talk between detectors, and stray light may contribute to the uncertainty, but these factors have not been evaluated. Uncertainty in the 6S atmospheric algorithm has not been evaluated.

10.2.3 Measurement Error for Parameters

None given.

10.2.4 Additional Quality Assessments

Spectral response curves for selected training areas are plotted and examined for known atmospheric absorption features. These plots are also compared to similar measurements made by other instruments, if data are available.

10.2.5 Data Verification by Data Center

BORIS staff reviewed the data files submitted by the RSS-02 team for content and consistency with the provided documentation.

11. Notes

11.1 Limitations of the Data

The ASAS multiangle images have not been georegistered, and though the sampled areas are selected carefully, they are not guaranteed to represent the exact same area in each image.

11.2 Known Problems with the Data

Image Data and Derived Products:

- ASAS data acquired over the SSA calibration target (a soil field) were atmospherically corrected and compared to ground measurements. The results show ASAS to agree very well with the ground observations between 490 and 870 nm. Below 490 nm and above 870 nm, the ASAS response falls below the expected level. Extreme ASAS channels have much lower signal to noise ratios.
- Though a specific sequence of view angles from +70 to -55 degrees was attempted for each flightline over the flux tower sites, not all look angles were achieved every time. Often the 70-degree off-nadir view missed the site or contained too much distortion for inclusion in the data set. Other angles may be missing as well.

Reflectance Factor Tables:

- In general, atmospheric correction by 6S effectively removes the scattered path radiance in the visible, and diminishes the dips caused by gaseous absorption. However, a plot of reflectance factor vs. wavelength may show, for some data sets, that some dramatic dips and spikes still exist in the atmospherically corrected data. These result from either overcorrection or undercorrection due to the difficulty of estimating the effect of absorption bands of varying widths. See Brown de Colstoun et al.(1995) for a discussion of this issue.

11.3 Usage Guidance

At present, the reflectance factor tables originated from ASAS images which were not georectified or geolocated. Georegistered images may be available in the future. Contact ASAS staff or check the ASAS homepage (http://asas.gsfc.nasa.gov/) for updates on available data.

Use special caution (or avoid) working with data from channels below 490 nm or above 870 nm (see Section 11.1).

It is strongly suggested that you plot reflectance factor vs. spectral band number or band center and view each data set for unusual dips and spikes. Affected bands should be avoided, and/or some smoothing algorithm should be applied to the data before use.

11.4 Other Relevant Information

None.

12. Application of the Data Set

None given.

13. Future Modifications and Plans

None given.

14. Software

14.1 Software Description

The IDL data analysis and visualization software package was used.

14.2 Software Access

IDL is available from:

Research Systems, Inc.
2995 Wilderness Place
Boulder, CO 80301
(303) 786-9900
http://www.rsinc.com/

15. Data Access

The reflectance factor data are available from the Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

15.1 Contact Information

For BOREAS data and documentation please contact:

ORNL DAAC User Services
Oak Ridge National Laboratory
P.O. Box 2008 MS-6407
Oak Ridge, TN 37831-6407
Phone: (423) 241-3952
Fax: (423) 574-4665
E-mail: ornldaac@ornl.gov or ornl@eos.nasa.gov

15.2 Data Center Identification

Earth Observing System Data and Information System (EOSDIS) Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC) for Biogeochemical Dynamics http://www-eosdis.ornl.gov/.

15.3 Procedures for Obtaining Data

Users may obtain data directly through the ORNL DAAC online search and order system [http://www-eosdis.ornl.gov/] and the anonymous FTP site [ftp://www-eosdis.ornl.gov/data/] or by contacting User Services by electronic mail, telephone, fax, letter, or personal visit using the contact information in Section 15.1.

15.4 Data Center Status/Plans

The ORNL DAAC is the primary source for BOREAS field measurement, image, GIS, and hardcopy data products. The BOREAS CD-ROM and data referenced or listed in inventories on the CD-ROM are available from the ORNL DAAC.

16. Output Products and Availability

16.1 Tape Products

None.

16.2 Film Products
None.

16.3 Other Products
These data are available on the BOREAS CD-ROM series.

17. References

17.1 Platform/Sensor/Instrument/Data Processing Documentation
Kovalick, W. and D. Graham. 1991. ASAS Programmer's Manual. Hughes STX, Code 923, NASA GSFC, Greenbelt, MD (in-house document).

Tanre, D., J.L. Deuze, M. Herman, R. Santer, and E. Vermote. 1990. Second simulation of the satellite signal in the solar spectrum - 6S code [abs]. In Proceedings of the 10th Annual Geoscience and Remote Sensing Symposium, vol. I, p. 187, IEEE Int. Geosci. and Remote Sens., New York.

Vermote, E.F., D. Tanre, J.L. Deuze, M. Herman, and J.J. Morcrette. 1997. Second simulation of the satellite signal in the solar spectrum: an overview. IEE Trans. Geosci. Remote Sens.

The 6S User Guide and code can be obtained via anonymous ftp on kratmos.gsfc.nasa.gov.

Information on ASAS data and the ASAS sensor can be obtained on the world-wide web at: http://asas.gsfc.nasa.gov/

17.2 Journal Articles and Study Reports
Many of the following articles describe data from the first-generation CID array (prior to 1991). Radiometric resolution factors and spectral band centers differ among the various ASAS data sets. A more complete bibliography can be found in the documentation for ASAS Level 1b images.

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17.3 Archive/DBMS Usage Documentation

None.

18. Glossary of Terms

None.

19. List of Acronyms

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6S       - Second Simulation of the Satellite Signal in the Solar Spectrum
AGL      - Above Ground Level
ARC      - Ames Research Center
ASAS     - Advanced Solid-state Array Spectroradiometer
ASCII    - American Standard Code for Information Interchange
AVIRIS   - Airborne Visible InfraRed Imaging Spectrometer
BOREAS   - BOReal Ecosystem-Atmosphere Study
BORIS    - BOReas Information System
BRDF     - Bidirectional Reflectance Distribution Function
CCD      - Charge-Coupled Device
CD-ROM   - Compact Disk - Read-Only Memory
CID      - Charge-Injection Device
DAAC     - Distributed Active Archive Center
EOS      - Earth Observing System
EOSDIS   - EOS Data and Information System
FFC-T    - Focused Field Campaign - Thaw
FOV      - Field of View
FWHM     - Full-Width Half-Maximum
GIS      - Geographic Information System
GMT      - Greenwich Mean Time
GSFC     - Goddard Space Flight Center
HDR      - Header
IDL      - Interactive Data Language
IFC      - Intensive Field Campaign
IFOV     - Instantaneous Field of View
JSC      - Johnson Space Center
MISR     - Multi-Angle Imaging Spectro-Radiometer
NAD83    - North American Datum of 1983
NASA     - National Aeronautics and Space Administration
NIST     - National Institute of Standards and Technology
NSA      - Northern Study Area
OA       - Old Aspen
OBS      - Old Black Spruce
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OJP     - Old Jack Pine
ORNL    - Oak Ridge National Laboratory
PANP    - Prince Albert National Park
RSS     - Remote Sensing Science
SIS     - Scanning Imaging Spectroradiometer
SPP     - Solar Principal Plane
SSA     - Southern Study Area
URL     - Uniform Resource Locator
WFF     - Wallops Flight Facility
YJP     - Young Jack Pine
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The BOREAS RSS-2 team derived atmospherically corrected bidirectional reflectance factor means from multispectral, multiangle ASAS imagery for small homogeneous areas near several BOREAS sites. The ASAS imagery was acquired from the C-130 aircraft platform in 1994 and 1996. The data are stored in tabular ASCII files.

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